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A FRESNEL COLLECTOR PROCESS HEAT EXPERIMENT
AT CAPITOL CONCRETE PRODUCTS

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ABSTRACT

Applied Concepts will plan, conduct and evaluate for JPL an experiment to determine the feasibility of using a Power Kinetics' Fresnel concentrator to provide process heat in an industrial environment. The system user will be Capitol Concrete Products of Topeka, Kansas. The plant will provide process steam at 50 - 60 psig to two autoclaves for curing masonry blocks. When steam is not required, the plant will preheat hot water for later use.

A second system will be installed at the JPL parabolic dish test site for hardware validation and experiment control. Both plants will be instrumented to provide technical performance data. Experiment design will allow for the extrapolation of results to varying demands for steam and hot water, and will include a consideration of some socio-technical factors such as the impact on production scheduling of diurnal variations in energy availability.

A final report in December 1982 will evaluate technical performance and operational feasibility based on 12 months' operational experience at the industrial and test sites.

BACKGROUND

Applied Concepts and its subcontracted partners will conduct for JPL an experiment to evaluate the feasibility of a Fresnel mirror solar thermal conversion system to provide process steam and hot water in an industrial facility. Applied Concepts will provide experiment planning and supervision and will evaluate experimental results. Power Kinetics, Inc. will be a major partner in the experiment. They will manufacture and install the solar conversion systems. They will also provide engineering services in support of experiment planning and evaluation. Capitol Concrete Products of Topeka, Kansas, will operate and maintain the system for one year subsequent to plant installation and check out. They will also be responsible for site preparation to receive the solar energy system. The University of Kansas Research Center, Inc. will provide Capitol Concrete with expert assistance in experiment planning and reporting.

The experiment, which involves the installation of the PKI system in a fuel-saving mode at the Capitol Concrete Plant, is designed

to evaluate the technical performance of the solar hardware in an industrial environment. It will also evaluate those socio-technical factors which are created when a new technology is first introduced into an industrial application where it places new demands on the user.

THE APPLICATION

Capitol Concrete Products is a manufacturer of masonry blocks. Concrete blocks, once formed, must be cured to attain the strength necessary to their use in load bearing construction. Such curing can be done over a period of months by exposure to rain and weathering, over a period of days by exposure to hot water, or over a period of hours by exposure to pressurized steam. According to a SERI study (Ketels and Reeves), nationwide, this process consumes some $1.6 \cdot 10^9$ KWh (thermal) or $5.4 \cdot 10^{12}$ BTU per year, or about one per cent of all U.S. medium temperature industrial steam.

Capitol Concrete has two 60 psig autoclaves which are served by a 6000 pound/hour capacity, natural gas-fired boiler. The process, which requires approximately 10 hours at pressure, is currently utilized five days per week, and produces some 16,000 blocks per day.

The current production schedule at Capitol Concrete did not evolve for the utilization of solar energy. It is not optimal for its application. Blocks, which are made during the morning hours, are loaded into the autoclaves in the early afternoon. The first autoclave is brought up to pressure about 2:00 PM. Pressure is maintained overnight, and at 6:00 AM, the first worker to the plant releases pressure and prepares for unloading.

There is no technical reason for the current schedule. Blocks, once formed, could be stored until next morning and cured on a ten hour schedule consistent with maximum insolation. Under experimental conditions, we do not propose to alter the manufacturer's operational procedures. The relatively small contribution which a single module will make to overall consumption does not warrant such a change.

Experiment design, however, incorporates the extrapolation of results to evaluate the value of a change in operational procedures to match the availability of energy. Moreover, during morning hours, Capitol Concrete plans to utilize the solar conversion system in a water pre-heat mode. This full utilization of the system during daylight hours will allow the extrapolation to full-time steam production to be made. It also offers the advantage of extrapolating results for those masonry manufacturers who utilize a hot water curing system. It allows the testing of the PKI system in a dual mode configuration.

The Capitol Concrete site is in an industrial area near the north shore of the Kansas River. Annual direct normal insolation

is about 1850 KWh/m². The major local environmental factor which is anticipated to impact on system performance is a sand pile on an adjacent lot from which the wind blows sand particles toward the Capitol Concrete site.

The precise location of the energy conversion system will be selected in January 1981. It may be roof mounted over the boiler room, or ground mounted in a nearby block storage lot. PKI has also proposed mounting the collector on an elevated frame with room underneath for block storage or parking. The best option will be selected based upon a consideration of cost versus program resources.

PLANT DESIGN

The PKI Fresnel concentrating collector was discussed in an earlier paper, and therefore need not be described in detail here.

The system to be installed at Capitol Concrete will provide, at nominal capacity and full insolation, some 170 pounds per hour of 50 psig steam. This is three per cent of the total plant load. When steam is not required, the system will be used to preheat water for later use. Figure 1 presents a conceptual design of the proposed Capitol Concrete plant. It should be noted that a small, fuel displacement design was chosen to help assure that experimental system downtime will have a minimal impact on normal production operations.

Before the Capitol Concrete system is installed, a complete, instrumented PKI system will be erected and tested at JPL's Parabolic Dish Test site at Edwards AFB, California. Prior to its installation, the Capitol Concrete conversion system will be tested at the subassembly level at PKI. Applied Concepts will provide engineering design of the plant interface, and will supervise installation, plant integration and check out to be accomplished at the site prepared by Capitol Concrete by a team of Applied Concepts, PKI and Capitol Concrete personnel.

THE EXPERIMENT

Capitol Concrete will operate and maintain the experimental system for a period of twelve months after installation and check out, under the supervision of Mr. Joe Perry, Production Manager. The University of Kansas Research Center will provide plant personnel with expert assistance for reporting experimental results and with trouble shooting, if necessary. Applied Concepts and PKI will be on call should major problems develop.

PKI is designing an automated data gathering system which will integrate with the standard control system of the collector

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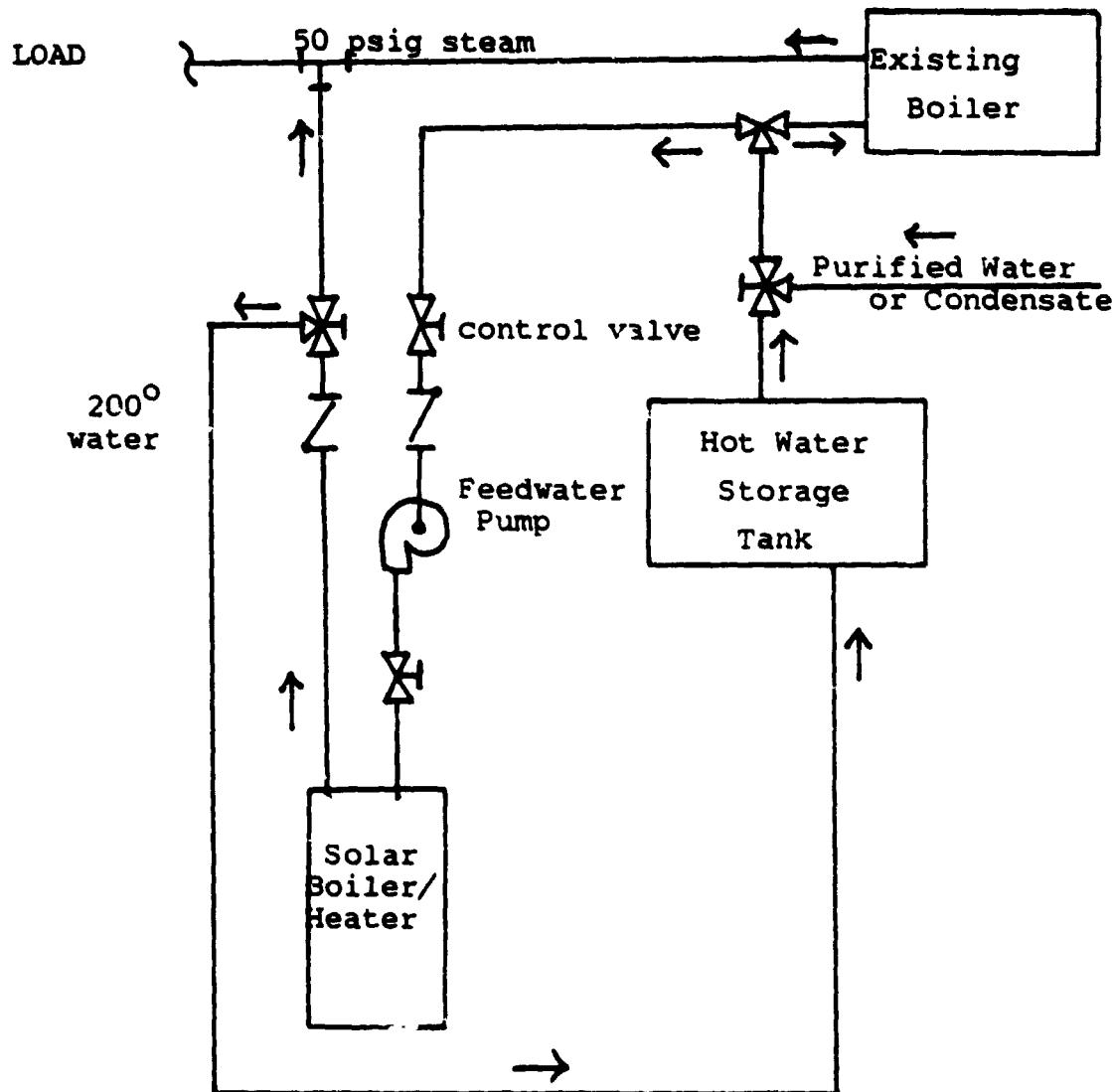


Figure I Conceptual Design, Capitol Concrete Plant

to provide technical performance data. In addition to 27 system variables which are currently monitored through the control system, instrumentation will record direct and total horizontal insulation, feedwater flow and temperature, system pressure, output temperature, ambient temperature, load steam status, condensed water run off, and parasitic power consumption. Data tapes will be collected and evaluated monthly.

It is the intention of Applied Concepts that the system to be installed at the JPL PDTS serve as an experiment control. It will be instrumented in the same way as the Capitol Concrete system. Applied Concepts will provide JPL with an experiment operation plan for its implementation. Data provided by JPL will be analyzed and compared with the results of operations in Topeka.

In addition to evaluating technical performance data on the PKI hardware, Applied Concepts will work with Capitol Concrete and the University of Kansas Research Center to evaluate the operational impact of system use. Results should be meaningful for the larger industrial environment. The energy products of the experiment (medium pressure steam and hot water) have broad industrial application. A fuel saving plant configuration is no doubt the most general one for realistic industrial application. Capitol Concrete was not chosen to be an "ideal" user as might be appropriate to a demonstration project, but as a representative user as is more appropriate to an industrial application experiment. The experiment is designed to provide us with information therefore on both the technical performance of a parabolic dish type system in an industrial environment and also on the interaction between the system and the environment in which it is to be used.

A final report is anticipated in December 1982.